MUSTANG

A MUltiple Space and Time scale Approach for the quaNtification of deep saline formations for CO2 storaGe

Project Number:227286

Work-Package: WP01

MANAGEMENT

Deliverable D1.3

Technology implementation plan

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Management

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Executive summary	
This deliverable presents a framework for the deployment of the findings in MUSTANG that have a technological implementation potential. Six partners of the consortium have reached such a level (UU, EWRE, UGOE, CSIC, UEDIN and VIBROMETRIC) offering expertise and know-how, software and hardware. It is suggested to form a flexible structure integrating these partners and others with relevant solutions that could be capable of offering integrated solutions for the design, planning and implementation of CO_2 storage. Since the industrial deployment in Europe is almost non-existent, it is suggested to maintain the R&D investment in order to maintain this acquired know-how at a state of the art level.	
Keywords	CO_2 storage planning and design, monitoring, modeling.

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1. Introduction

This document summarizes a tentative technology implementation plan subsequent to the developments achieved in MUSTANG. Among the MUSTANG consortium the partners with potential for technological development are UU, EWRE, UGOE, CSIC, CNRS, UEDIN, IMAGEAU and VIBROMETRIC.

In order to establish a technological implementation plan we first determined the relevant fields as follows:

1. A specific product (software and or hardware) that could be commercialized;
2. Expertise that could be offered as a service.

First, related partners were asked to answer a number of questions aimed a better focusing of the deployable productions.

Question #	Question
Q1	Has your work in MUSTANG led to the development of any specific product?
Q2	If answer to Q1=YES, specify 1) if it was in the field of CO_2 storage; 2) any other field; 3) both.
Q3	If answer to Q1=NO, can your work in MUSTANG be developed to a specific product?
Q4	If answer to Q3=YES if yes , specify 1) if it was in the field of CO_2 storage; 2) any other field; 3) both
Q5	If Q1 = YES and/or Q3 = YES provide a short description of the product
	Provide short information on the degree of development - 1) concept; 2) prototype with proof of concept; 3) full product without field maturity; 4) full product with field maturity.

In second phase we suggest delineate the actual plan for the technology implementation, based on the answers received from the partners.

2. Products developed in MUSTANG

As a first step, we screened the potential partners according to the answers they provided to questions Q1 and Q3 (whether they have developed any product that could be implemented).

Partner	Answer	Product type
UU-AN (Auli Niemi group)	YES	Expertise, software
UU-CJ (Chris Juhlin group)	NO	
EWRE	YES	Expertise, software.
UGOE	YES	Expertise, Hardware
CSIC	YES	Software
CNRS	NO	
UEDIN	YES	Expertise, software
IMAGEAU	NO	
VIBROMETRIC	YES	Hardware

2.1 UU-AN

The Auli Niemi group within partner UU has worked, beyond coordination, on the design and planning of the Heletz CO_2 of injection experiments the configuration (together with EWRE) of

the wells instrumentation (tendering and procurement) and definition of the monitoring technologies deployed at Heletz.

UU has also carried out significant modelling work, both code development and development of modelling procedures. Of codes developed within the project the two-phase flow and species (tracer) transport code allowing kinetic time-dependent transfer of the chemical over phase boundary can be mentioned.

UU has so-far used the gained expertise in the frame of the national and Baltic CCS development programs.

2.2 EWRE

In the frame of MUSTANG, EWRE team devoted most of the allocated effort to the design and planning of the field injection experiment and on modelling CO_2 storage. The activities related to the field experiments including, site exploration and selection, well location, well design (drilling and completion), monitoring technologies, well stimulation, design of a CO_2 injection system, site organization, logistics, tendering and procurement. Substantial expertise has been gathered and deployed in the field and this could be offered as service provider and/or consulting. Part of the experience gained at Heletz was transferred to the design and planning of the Hontomin site.

EWRE extended its proprietary software platform for data analysis and visualization so it can pre and post-process more efficiently CO_2 injection simulation models driven by the LANL PLFOTRAN simulator. Additionally we have developed a simple yet effective code for the simulation of CO_2 flow in the injection tube. We can qualify these developments as mature and ready for commercialization.

2.3 UGOE

UGOE has developed two products:

JSWIWTT: Joint Single-Well Inter-Well Tracer Technology for quantifying fluid transport parameters, with improved on-site management of fluid supply/disposal, reducing hydraulic imbalance, fostering hydro-geomechanical stability, and reducing the ambiguity of tracer signal inversion. This is basically an expertise.

The development of JSWIWTT is at the conceptual level. We plan to implement it at the Heletz site, evaluating the results, applying the concept at further sites within deep-georeservoir R&D projects. Commercially deployable expected by year 2020.

PISOT: Passive in-situ sampling technique for two organic tracer species, to avoid issues with tracer co-precipitation upon fluid depressurization and oxygen input. PISOT is a mix of expertise and hardware.

PISOT is a product with full field maturity. The technique (hardware + expertise) will be deployed at the Heletz site and at further sites within deep-georeservoir R&D and/or commercial projects. Commercially deployable product as of today.

2.4 CSIC

CSIC has developed a THM module (Thermal-Hydraulic-Mechanical) in their PROOST software platform for the investigation of mechanical impacts subsequent to the injection of CO_2. The

software platform is still under development but has reached the level of fully developed product without field/market maturity.

2.5 UEDIN

UEDIN has been actively contributing to the development of a new approach to FE modelling implemented in OpenGeoSys (www.OpenGeoSys.org). This is a knowledge base increase, no specific commercial value.

Expertise: a new approach for fracturing caprocks, and estimating the spacing of fractures developed by fluid overpressure. Knowledge base increase, may have long term impact but no specific value at this stage.

Development of Geomechanical Facies Concept allowing holistic comparison of different geological sites and settings with relevance to sub surface geo-engineering. This is a knowledge base, demonstrated for geothermal work, CO_2 work and soon for fracking.

Experimental investigation of fluid flow in low permeability fractured rock experimental expertise, already of interest to commercial parties.

2.6 VIBROMETRIC

VIBROMETRIC has developed the following products:

24-level, 4-component/level, deep borehole seismic receiver chain: Digital receivers, with 4-components/level were developed independently of the MUSTANG project. The tool has individually programmable amplifiers and 24-bit down-hole A/D conversion for up to 96-levels on a wireline cable. Its modules are interchangeable, with software-driven reconfiguration. The 4th component can be a hydrophone or a 1-Hz geophone, to provide a low-frequency solution. Although the development of the tool was funded independently of the Mustang Project, is has been integrated to the active and passive seismic monitoring at Heletz.

This is a full product without field maturity. To acquire field maturity, the product is still to be fully proven at Heletz before and during injection. The low frequency capability is not yet commercially widely requested. However, in its standard band version the tool has been used in several mining-related 3D-VSP surveys.

Low Frequency Seismic Source: A prototype low frequency surface seismic source has been built based on the VIBSIST concept. The prototype is light and mobile, to serve the current needs of the project. However, the source emits a wide-band signal, extended to the lower part of the spectrum. The initial objective was to develop a near surface 'permanent' source. Later in the project it has been considered that placing a permanent prototype source at a predetermined fixed location would make problematic if not impossible the detection by seismics of such a small CO_2 plume as derived through modelling. The same concept can however be used both for mobile and for permanent subsurface installations.

This product is a prototype with proof of concept: The source has been used extensively in projects not related to CO_2 capture and has proven its commercial worth. However, it has not yet been tested for this specific application and some technical variations are steel expected to occur. A commercial version will start being offered in 2015.

3. Summary

Eight partners from the MUSTANG consortium were identified with capability to develop products that could be implemented. Out these eight potential "producers" only six have actually achieved a technological development.

The technological products include:

1. Expertise (UU, EWRE, UGOE and UEDIN) that could be offered by means of consulting at various levels (field experiments, laboratory experiments, design and planning of CO_2 injection, field characterization).
2. Software (EWRE, CSIC and UEDIN) that could deployed either commercially or not for an improved analysis and modeling of CO_2 storage.
3. Hardware (UGOE, VIBROMETRIC): part of this hardware is mature and commercialized, part will be commercial in the near and mid-future.

It must be stressed that there is no overlapping the development of software and hardware and partial overlapping in expertise (mainly UU and EWRE).

4. Suggested implementation

One way to implement the technologies developed within MUSTANG is that every involved partners offers services and products on an individual basis, in CO_2 related markets and beyond (oil and gas industry, environmental protection, water resources management). De facto this is already happening: UU is already using the knowledge and expertise gained in MUSTANG for the development of the Swedish and Baltic CCS program, VIBROMETRIC and UGOE are deploying the hardware they have developed, UEDIN and EWRE are already providing services based on the knowledge acquired in MUSTANG.

A second implementation that is already happening resides in the fact that most of the partners are cooperating in CO_2 storage projects funded by the EU (PANACEA, TRUST, CO_2QUEST). These projects are helping in further developing the reported products and expertise and additional ones.

Altogether, MUSTANG has contributed to the development of European expertise in the field of CO_2 storage, which could be used by both the industrial and regulatory sectors. The wide geographical diversity of the partners and their structures does not allow to create a common, rigid structure, capable of delivering integrated solutions in the field of CO_2 storage, which could be the ideal outcome of the project. However, we could envisage a flexible structure with add-hoc per project cooperation between partners, in order to suggest design and planning expertise as well as technologies (those developed in MUSTANG and the subsequent projects). MUSTANG has laid out the ground for the formation of such a structure and the continuation projects will provide the opportunity to materialize it.

The biggest problem however, is that industrial deployment of CO_2 storage in Europe has not been a success so far and in order to keep this expertise developing and state of the art,

additional R&D projects are needed to better cements the groups and to consolidate the R&D knowledge into field deployable technological solutions.